

# Aspects of the Feeding Ecology of the Little Grass Frog, *Pseudacris ocularis* (Anura: Hylidae)

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**ABSTRACT**—We report on the foods of the little grass frog, *Pseudacris ocularis*, from Georgia. Fifty specimens were collected from two isolated wetlands located in Evans and Grady counties, Georgia, during late spring and summer 1993. Analysis of stomach contents determined that the most abundant food items were small arthropods associated with leaf litter and soil. Almost 50% of the food items were collembolans, followed by hymenopterans (17%), acarines (9%), homopterans (8%), and coleopterans (8%). We compared foods of adult males with those of newly metamorphosed juveniles collected at the same time from the Grady County site. Juvenile frogs ate more individual food items and a greater diversity of prey species than did adult males. This difference could be due to adult *Pseudacris* selecting larger, more profitable prey than juveniles select. Lower feeding activity exhibited by breeding males might also be a contributing factor.

Little is known about the feeding ecology of many amphibians, especially intraspecific variability in foods and foraging (Duellman and Trueb 1986). Variation in dietary preferences among population subgroups (e.g., breeding males, non-breeding females, subadults, juveniles, larvae, etc.) has been reported to reflect differences in habitat preference (Lamb 1984), gape (Toft 1980), developmental condition (Brophy 1980, Davic 1991), and other factors.

The little grass frog, *Pseudacris ocularis* (Bosc and Daudin), is the smallest North American anuran (Conant and Collins 1991). It occurs in a wide variety of ephemeral and semi-permanent wetlands in the southeastern Coastal Plain and favors grassy areas in and around cypress ponds and similar sites (Harper 1939, Mount 1975). In spite of its relative abundance in many of these areas, virtually nothing is known of the feeding ecology of this frog. The purpose of our study was to describe the diet of *P. ocularis* and to investigate any potential differences between the feeding of adult frogs and newly metamorphosed juveniles.

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## MATERIALS AND METHODS

We collected 50 *P. ocularis* for stomach analysis from two localities during May–July 1993. Both sites were ephemeral wetlands in the lower Coastal Plain of Georgia. The first site, located in Grady County, was dominated by black gum (*Nyssa sylvatica*) and was situated in a low pine flatwood having a canopy of slash pine (*Pinus elliotii*) and an understory of saw palmetto (*Serenoa repens*) and gallberry (*Ilex glabra*). The second, in Evans County, was a dome of pond cypress (*Taxodium ascendens*) surrounded by sandhills dominated by longleaf pine (*P. palustris*) and turkey oak (*Quercus laevis*). Areas similar to both sites were described in detail by Wharton (1978).

After collection, all specimens were preserved in 10% formalin, and stored in 35% isopropanol. Each frog was measured for snout-vent length (SVL) and dissected for stomach analysis. Individual food items were counted and identified. Because prey items were too small to use volumetric displacement, relative importance of prey was determined by comparing each individual prey item to a paper grid and visually estimating the number of grid squares occupied (Camp and Bozeman 1981).

Twenty of the Grady County frogs were collected between 2200 and 2400 EDT on 5 June. This sample consisted of 10 mature males and 10 juveniles that had just completed metamorphosis. We used this sample to make comparisons between feeding of adults and juveniles. Because we did not independently test for prey availability, other collections were not used for comparisons because of possible complications arising from temporal or between-site differences in available prey items. In addition, although adult females were included in these samples, small numbers ( $n = 4$ ) precluded between-sex comparisons. Correlation between the number of prey items eaten and body size was tested using the procedure described by Zar (1984). A comparison of diversity between adult male and juvenile prey species was made using the Shannon-Wiener Index of Diversity ( $H'$ ) (Zar 1984).

## RESULTS

One hundred-forty individual prey items were identified and consisted entirely of arthropods, mainly insects (Table 1). Springtails (Collembola) were the most numerous group, making up 47% of the food items eaten and found in 56% of the stomachs. Because they are so small, however, they contributed less than 20% of the area occupied by all prey items. Hymenopterans, especially ants (Formicidae)

Table 1. Stomach contents of 50 *Pseudacris ocularis* from the Coastal Plain of Georgia. Unless otherwise indicated, the smallest taxon in each order is represented by a single species; "i" represents immature instars. Numbers (*n*) for higher taxa also include unidentified food items.

| Food Item            | (n) | Percentage of |            | %<br>Frequency |
|----------------------|-----|---------------|------------|----------------|
|                      |     | Total Number  | Total Area |                |
| INSECTA              | 122 | 87.1          | 90.1       | 82.0           |
| Collembola           | 66  | 47.1          | 19.5       | 56.0           |
| Isotomidae           | 26  | 18.6          | 5.6        | 20.0           |
| Poduridae            | 2   | 1.4           | 0.5        | 4.0            |
| Sminthuridae         | 37  | 26.4          | 13.4       | 26.0           |
| Coleoptera           | 11  | 7.9           | 9.2        | 18.0           |
| Carabidae            | 1   | 0.7           | 1.6        | 2.0            |
| Cleridae             | 1   | 0.7           | 0.3        | 2.0            |
| Coccinellidae        | 1   | 0.7           | 1.1        | 2.0            |
| Staphylinidae (3)    | 5   | 3.6           | 4.3        | 6.0            |
| larvae               | 1   | 0.7           | 0.4        | 2.0            |
| Dictyoptera          | 2   | 1.4           | 19.1       | 2.0            |
| Blattidae            | 2   | 1.4           | 19.1       | 2.0            |
| Diptera (larvae) (3) | 3   | 2.1           | 1.2        | 6.0            |
| Homoptera            | 11  | 7.9           | 11.1       | 16.0           |
| Delphacidae (i)      | 10  | 7.1           | 10.9       | 14.0           |
| Hymenoptera          | 24  | 17.1          | 14.6       | 32.0           |
| Diapriidae           | 1   | 0.7           | 2.2        | 2.0            |
| Dryinidae            | 1   | 0.7           | 0.8        | 2.0            |
| Encyrtidae           | 1   | 0.7           | 0.1        | 2.0            |
| Evaniidae            | 2   | 1.4           | 6.4        | 2.0            |
| Formicidae           | 7   | 5.0           | 1.2        | 6.0            |
| Scelionidae          | 7   | 5.0           | 1.9        | 6.0            |
| Orthoptera           | 2   | 1.4           | 4.8        | 4.0            |
| Acrididae (i)        | 2   | 1.4           | 4.8        | 4.0            |
| Phasmida             | 1   | 0.7           | 9.6        | 2.0            |
| Phasmatidae          | 1   | 0.7           | 9.6        | 2.0            |
| Siphonaptera         | 1   | 0.7           | 0.1        | 2.0            |
| Thysanoptera         | 1   | 0.7           | 0.1        | 2.0            |
| Phlaeothripidae      | 1   | 0.7           | 0.1        | 2.0            |
| ARACHNIDA            | 18  | 12.9          | 9.9        | 22.0           |
| ACARINA              | 13  | 9.3           | 5.5        | 16.0           |
| Mesostigmata         | 1   | 0.7           | 0.1        | 2.0            |
| Oribatei (2)         | 12  | 8.6           | 5.4        | 14.0           |
| Araneida             | 4   | 2.9           | 4.2        | 6.0            |
| Anyphaenidae         | 1   | 0.7           | 1.6        | 2.0            |
| Palpigradi           | 1   | 0.7           | 0.2        | 2.0            |

and parasitic wasps (Scelionidae), were the second most important group, making up 17% numerically and occurring in 32% of the stomachs. Hymenopterans made up 15% of the relative area. Other important insect groups represented were coleopterans, particularly rove beetles (Staphylinidae), making up 8% of numbers, 9% of area, and occurring in 19% of the stomachs, and delphacid homopterans (7, 11, and 14%, respectively). Although found only occasionally, relatively large roaches (Dictyoptera) and walking sticks (Phasmida) made up a considerable amount of the total quantity of food eaten (19 and 10% of total area, respectively). The only non-insect food items found were arachnids. These consisted primarily of mites (Acarina), which made up 9% numerically, 6% of the area, and occurred in 16% of stomachs.

Juvenile frogs from the 5 June, Grady County sample had a mean SVL of 8.80 mm with a standard error (SE) of 0.21 mm. Adult males from this sample had a mean SVL of 14.87 mm and a SE of 0.23 mm. Food items eaten by these frogs are shown in Table 2. The Shannon-Wiener Index for juvenile prey species diversity ( $H' = 1.062$ ) was significantly larger than that for adults ( $H' = 0.739$ ;  $t = 3.27$ ,  $df = 45$ ,  $P < 0.01$ ). There was a negative correlation between number of food items eaten and frog size ( $r^2 = 0.25$ ,  $t = 2.18$ ,  $df = 14$ ,  $P < 0.05$ ).

## DISCUSSION

*Pseudacris ocularis* is commonly found on lower tree trunks and foliage up to a height of 1 m or more (Harper 1939); males prefer these sites as calling perches (Harper 1939, Mount 1975). However, the majority of food items we found were arthropods that are associated with leaf litter and/or soil (e.g., springtails, mites, dipteran larvae, staphylinids, ants, thrips, palpigrades, etc.). In addition, we found a large number of frogs on the ground, particularly during daytime collections. It is apparent, then, that *P. ocularis* spends a considerable amount of its foraging time on the ground.

According to optimal foraging theory (Pyke et al. 1977, Krebs 1978), a predator should choose prey that represent the greatest net energy gain and forage in areas where profitable prey are most frequently encountered. Considering the small size of these frogs, small abundant leaf litter arthropods such as springtails and mites might represent a relatively stable, predictable source of profitable prey. However, amphibians might find larger arthropod prey to be more profitable than small ones due to a proportionately smaller exoskeleton (Jaeger and Barnard 1981). Therefore, little grass frogs should

Table 2. Stomach contents of 10 juvenile and 10 adult *P. ocularis* collected 5 June 1993, Grady County, Georgia; "i" represents immature instars; \* indicates two species represented. Numbers for higher taxa also include unidentified food items.

| Food Item        | Juveniles |      | Adults   |      |
|------------------|-----------|------|----------|------|
|                  | <i>n</i>  | %    | <i>n</i> | %    |
| Collembola       | 9         | 27.3 | 10       | 45.5 |
| Isotomidae       | 4         | 12.1 | 9        | 40.9 |
| Sminthuridae     | 4         | 12.1 | 1        | 4.5  |
| Coleoptera       | 2         | 6.1  | 2        | 9.1  |
| Carabidae        | 1         | 3.0  | 0        | 0.0  |
| Cleridae         | 1         | 3.0  | 0        | 0.0  |
| Staphylinidae    | 0         | 0.0  | 2*       | 9.1  |
| Diptera (larvae) | 1         | 3.0  | 1        | 4.5  |
| Homoptera        | 3         | 9.1  | 5        | 22.7 |
| Delphacidae (i)  | 2         | 6.1  | 5        | 22.7 |
| Hymenoptera      | 5         | 15.2 | 1        | 4.5  |
| Formicidae       | 0         | 0.0  | 1        | 4.5  |
| Scelionidae      | 4         | 12.1 | 0        | 0.0  |
| Orthoptera       | 0         | 0.0  | 2        | 9.1  |
| Acrididae (1)    |           |      | 2        | 9.1  |
| Siphonaptera     | 1         | 3.0  | 0        | 0.0  |
| Thysanoptera     | 1         | 3.0  | 0        | 0.0  |
| Phlaeothripidae  | 1         | 3.0  |          |      |
| Acarina          | 9         | 27.3 | 0        | 0.0  |
| Meostigmata      | 1         | 3.0  |          |      |
| Oribatei         | 8*        | 24.2 |          |      |
| Araneida         | 1         | 3.0  | 1        | 4.5  |
| Anyphaenidae     | 0         | 0.0  | 1        | 4.5  |
| Palpigradi       | 1         | 3.0  | 0        | 0.0  |

feed more on larger prey when available. Our data would, in part, appear to confirm this hypothesis. For instance, relatively large immature delphacids made up < 7% of total food items. However, in the 5 June, Grady County sample of adults (Table 2), delphacids made up 23%, indicating these food items were probably more available at that time, although we do not have independent confirmation of prey abundance.

Newly metamorphosed *P. ocularis* ate more individual food items and a greater diversity of prey species than did adult males. Two factors may explain these results. First, there may be an ontogenetic shift in foraging strategy during post-metamorphic growth of *P. ocularis*. Such a shift has been inferred in *P. triseriata* (Christian 1982) where

adults select more optimal (i.e., large) prey than do juveniles, which indiscriminately feed on prey they encounter. This may be the result of larger animals being able to choose from a greater range of prey sizes, whereas smaller individuals are largely restricted to small prey, as is apparent in *P. crucifer* (Oplinger 1967). This shift would account for the lower diversity of prey species taken by adult *P. ocularis*. Second, the adult sample used in our comparisons consisted entirely of males. Several authors have reported a sharp decline in feeding activity by adult male frogs during the breeding season (Jenssen and Klimstra 1966, Lamb 1984). The males in our study were not breeding (the pond was completely dry) and only sporadically calling at the time of collection (5 June), although breeding had been previously observed at this site in March. Mount (1975), however, reported breeding congregations of *P. ocularis* as late as 29 July in nearby Houston County, Alabama, and Harper (1939) recorded vigorous chorusing in the Okefenokee during August and September. Therefore, since *P. ocularis* does breed throughout the summer, we cannot rule out the possibility of lower feeding activity in adult males during the time of our collections.

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#### LITERATURE CITED

- Brophy, T. E. 1980. Food habits of sympatric larval *Ambystoma tigrinum* and *Notophthalmus viridescens*. *Journal of Herpetology* 14:1–6.
- Camp, C. D., and L. L. Bozeman. 1981. Foods of two species of *Plethodon* (Caudata: Plethodontidae) from Georgia and Alabama. *Brimleyana* 6:163–166.
- Christian, K. A. 1982. Changes in the food niche during post-metamorphic ontogeny of the frog *Pseudacris triseriata*. *Copeia* 1982:73–80.
- Conant, R., and J. T. Collins. 1991. Reptiles and amphibians of eastern/central North America. Houghton-Mifflin, Boston, Massachusetts.

- Davic, R. D. 1991. Ontogenetic shift in diet of *Desmognathus quadramaculatus*. *Journal of Herpetology* 25:108-111.
- Duellman, W. E., and L. Trueb. 1986. *Biology of amphibians*. McGraw/Hill, New York, New York.
- Harper, F. 1939. Distribution, taxonomy, nomenclature and habits of the little grass frog (*Hyla ocularis*). *American Midland Naturalist* 22:134-149.
- Jaeger, R. G., and D. E. Barnard. 1981. Foraging tactics of a terrestrial salamander: choice of diet in structurally simple environments. *American Naturalist* 117:639-664.
- Jenssen, T. A., and W. D. Klimstra. 1966. Food habits of the green frog, *Rana clamitans*, in southern Illinois. *American Midland Naturalist* 76:169-182.
- Krebs, J. R. 1978. Optimal foraging: decision rules for predators. Pages 23-63 in *Behavioral ecology: an evolutionary approach* (J. R. Krebs and N. B. Davies, editors). Sinauer Publications, Sunderland, Massachusetts.
- Lamb, T. 1984. The influence of sex and breeding condition on microhabitat selection and diet in the pig frog *Rana grylio*. *American Midland Naturalist* 111:311-318.
- Mount, R. H. 1975. *The reptiles and amphibians of Alabama*. Alabama Agricultural Experiment Station, Auburn University, Auburn, Alabama.
- Oplinger, C. S. 1967. Food habits and feeding activity of recently transformed and adult *Hyla crucifer crucifer* Wied. *Herpetologica* 23:209-217.
- Pyke, G. H., H. R. Pulliam, and E. L. Charnov. 1977. Optimal foraging: a selective review of theory and tests. *Quarterly Review of Biology* 52:137-154.
- Toft, C. A. 1980. Feeding ecology of thirteen syntopic species of anurans in a seasonal tropical environment. *Oecologia* 45:131-141.
- Wharton, C. H. 1978. *The natural environments of Georgia*. Georgia Department of Natural Resources, Atlanta.
- Zar, J. H. 1984. *Biostatistical analysis*, Second edition. Prentice-Hall, Englewood Cliffs, New Jersey.

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